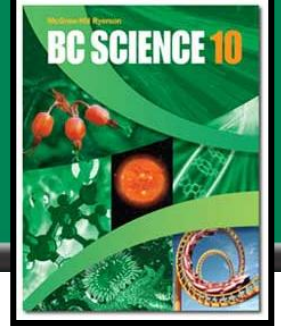
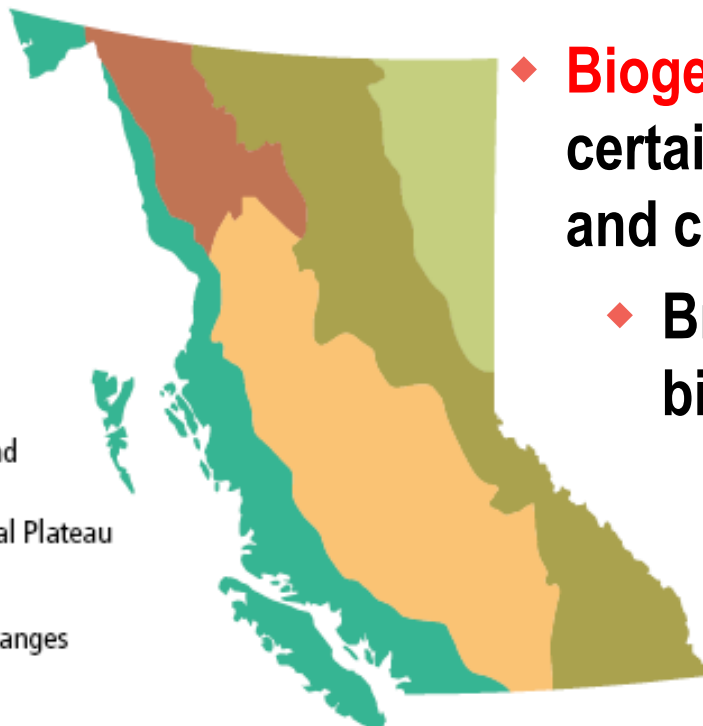


# Chapter 11 Climate Change



- **Climate - average conditions of a region.**
  - ♦ Measured over a minimum of 30 years or more.
  - ♦ Climate = clouds, precipitation, average temperature, humidity, atmospheric pressure, solar radiation, and wind.



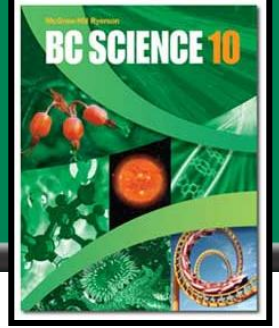
- ♦ **Biogeoclimatic zones** – regions with a certain type of plants, soil, geography and climate
  - ♦ British Columbia has 14 distinct biogeoclimatic zones.

**Climate Zones**

- Coast Mountains and the Islands
- Northern and Central Plateau
- Interior Plateau
- Eastern Mountain Ranges
- Northeast Plains

See pages 464 - 465

# Looking Forward by Studying the Past

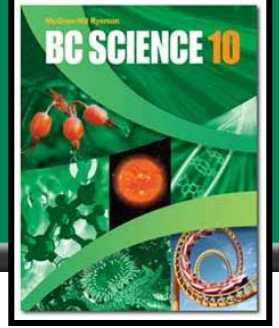


- **Paleoclimatologists** study long-term patterns in various regions.
  - Fossils
  - Tree rings
  - River sediments
  - Glacier ice cores

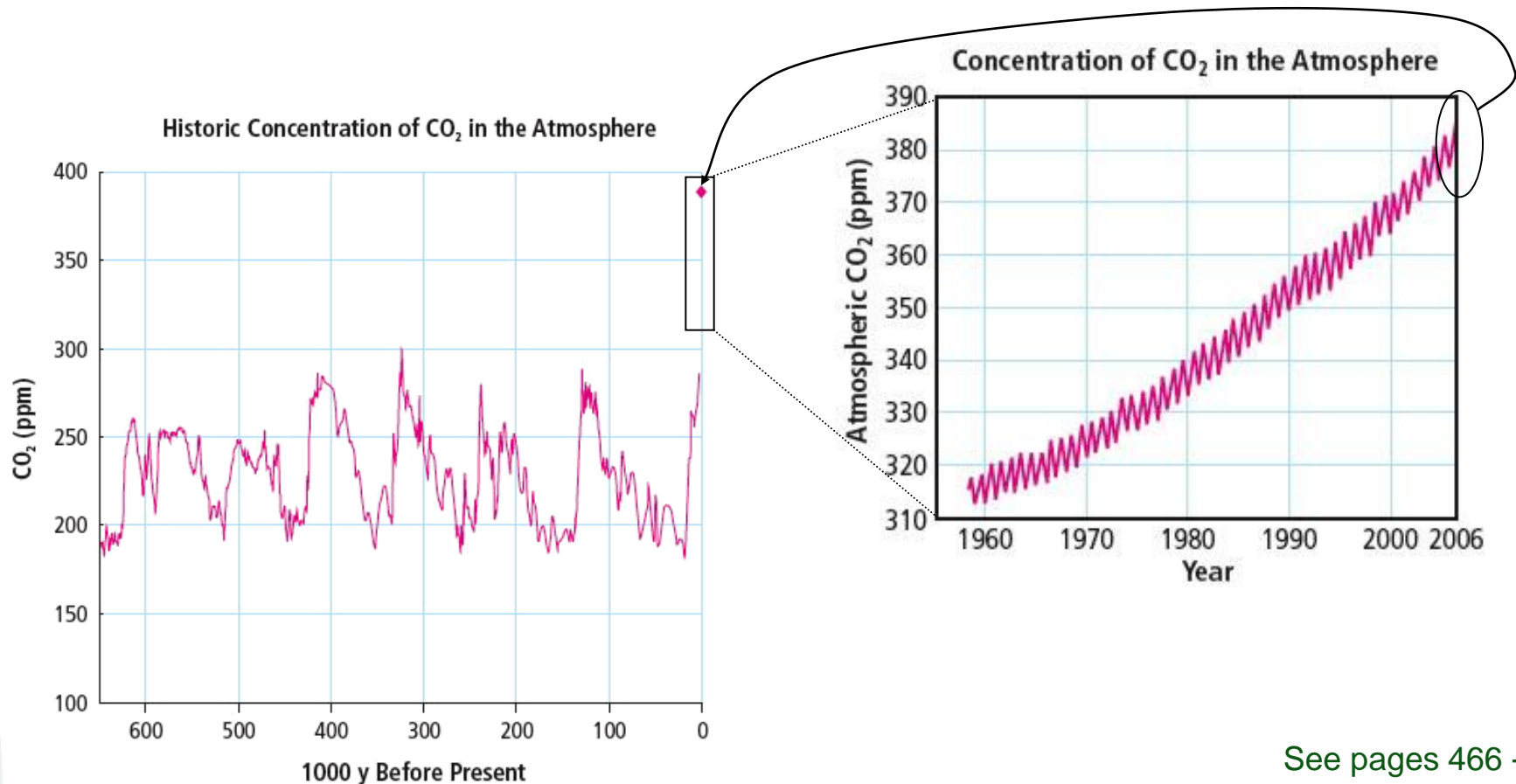


See pages 466 - 467

# Looking Forward by Studying the Past (continued)

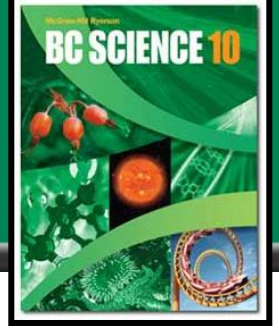


- Ice core data reveal CO<sub>2</sub> levels for the past 650 000 years.

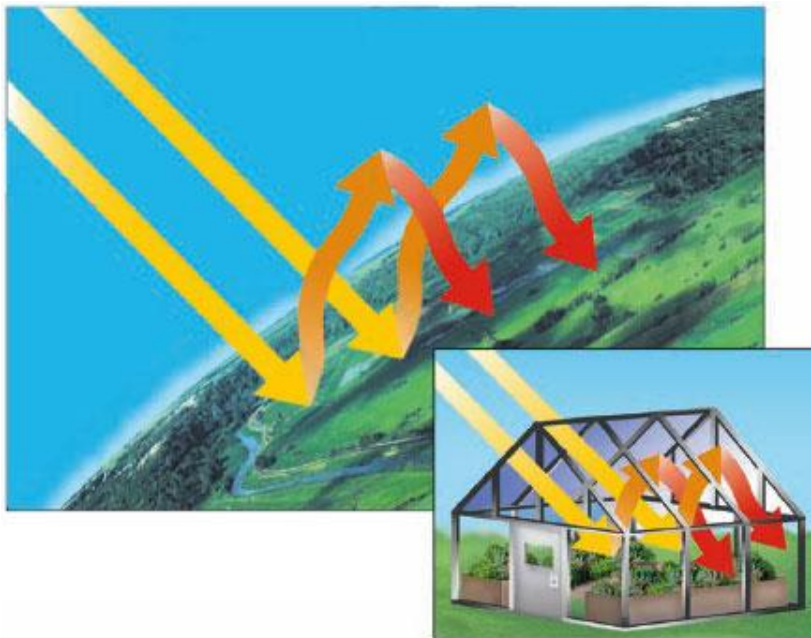


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# Factors That Influence Climate: Composition of Earth's Atmosphere



- Natural greenhouse effect
  - ♦ Greenhouse gases ( $\text{CO}_2$ , water vapour etc.) in the atmosphere absorb and trap **thermal energy** from sun



# Factors That Influence Climate: Earth's Tilt, Rotation and Orbit

- Earth's tilt is responsible for seasons in northern hemisphere.
- Earth also “wobbles” as it rotates on its axis.
- Earth's revolution around the Sun is elliptical, not circular.

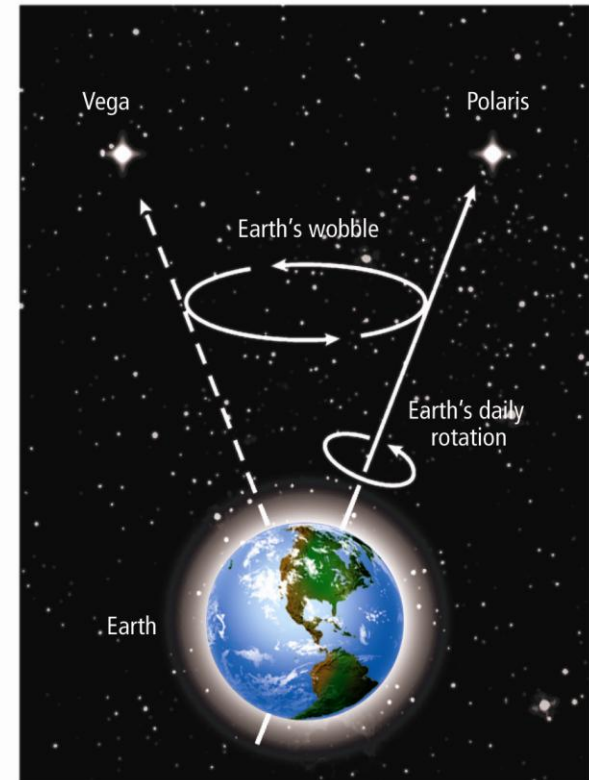
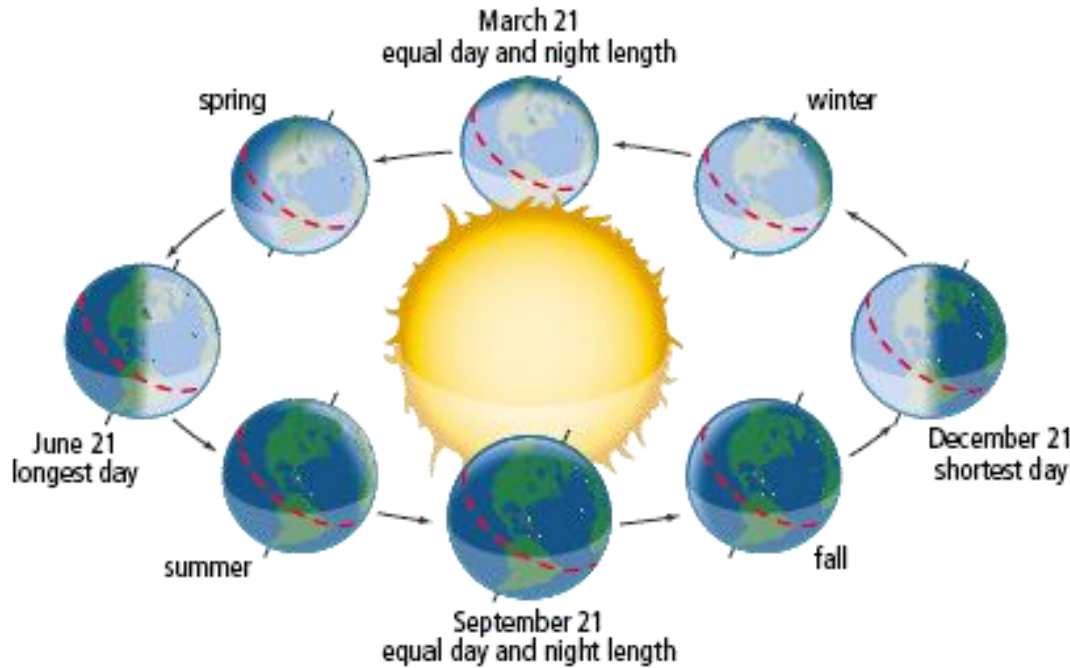
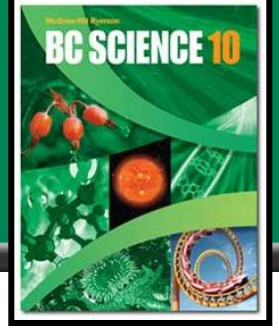


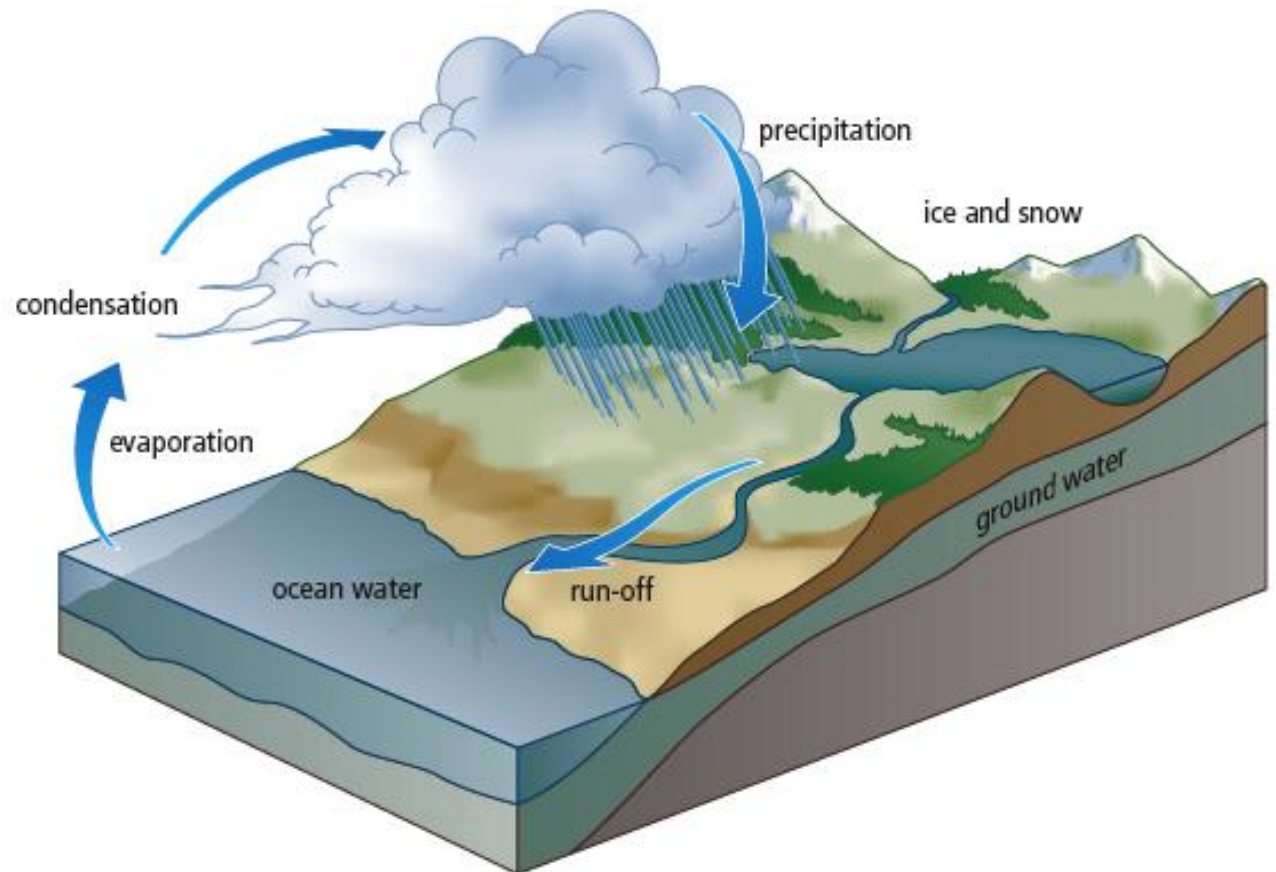
Figure 11.8 Earth wobbles as it rotates on its axis.



# Factors That Influence Climate: The Water Cycle

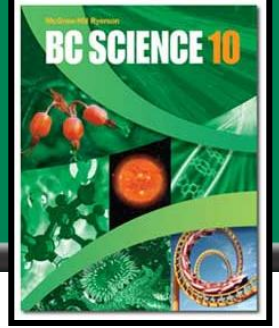


• **↑ water vapour = ↑ temperature**

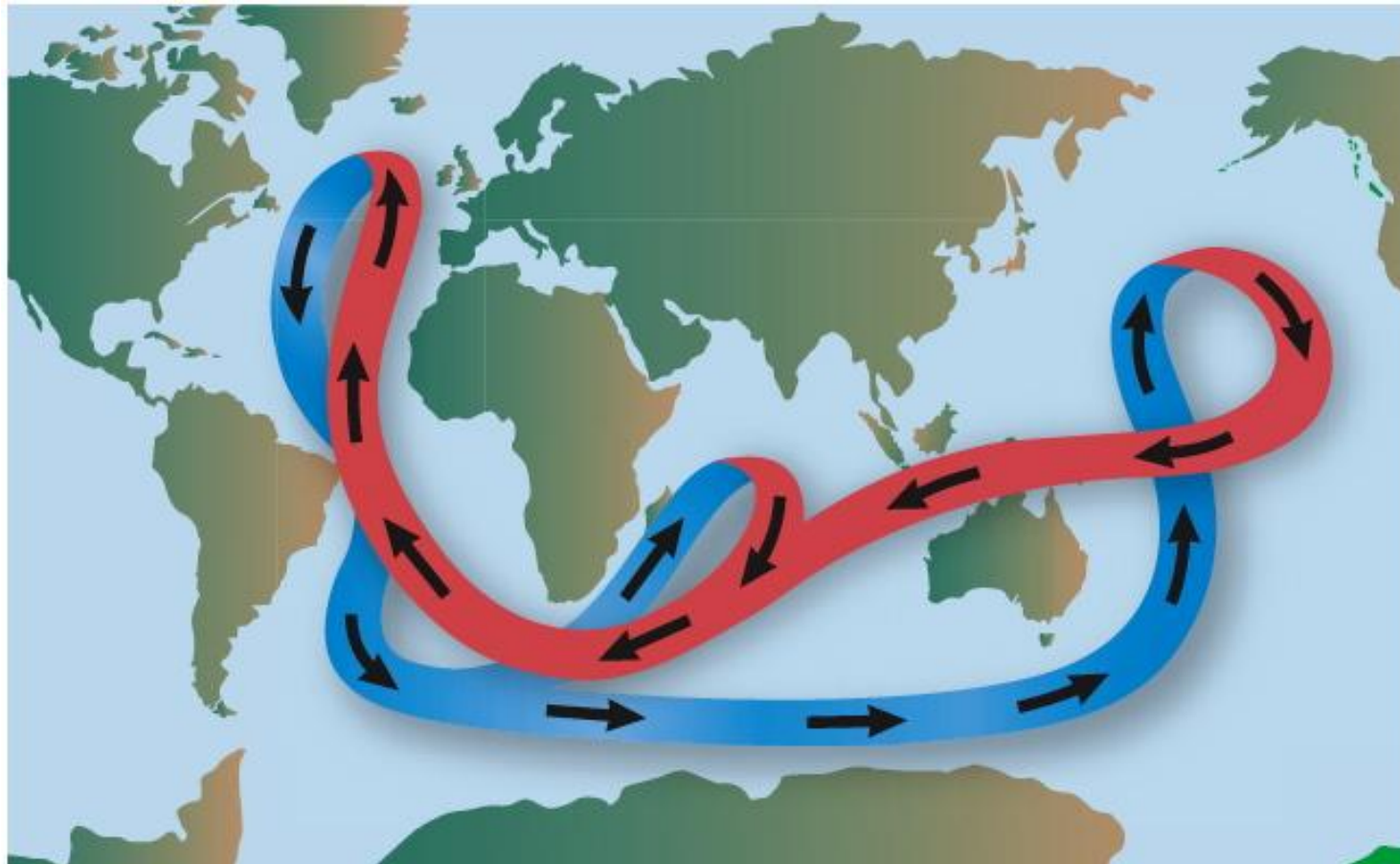


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# Factors That Influence Climate: Ocean Currents

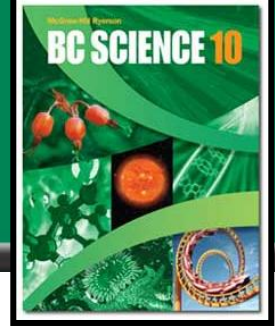


- **Convection currents** in oceans move large amounts of thermal energy all around Earth.



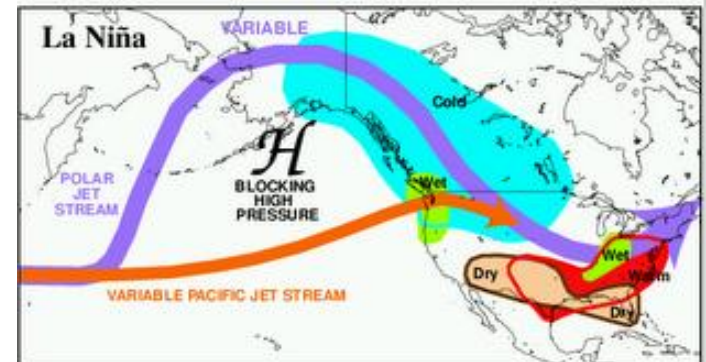
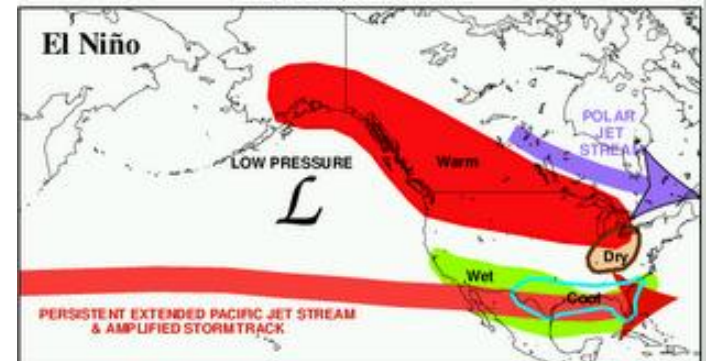
See pages 471 - 473

# Factors That Influence Climate: Ocean Currents (continued)



- **La Niña p. 478-479**
  - ♦ Cool water at the surface of the Pacific Ocean causes warm winters in southeastern North America, and cool winters in the northwest.
- **El Niño** is the reverse:
  - ♦ Warmer water on the surface of the Pacific Ocean results in warm winters in the Pacific Northwest and in eastern Canada.

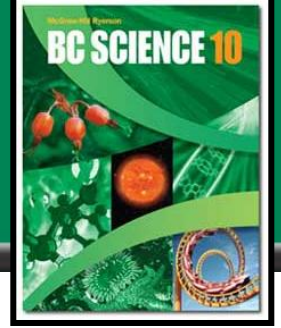
TYPICAL JANUARY-MARCH WEATHER ANOMALIES  
AND ATMOSPHERIC CIRCULATION  
DURING MODERATE TO STRONG  
EL NIÑO & LA NIÑA





# Factors That Influence Climate: The Carbon Cycle

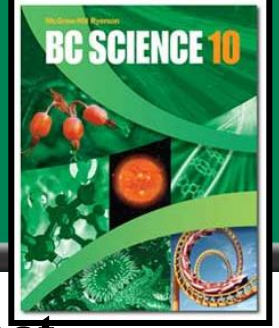
See pages 473 - 474



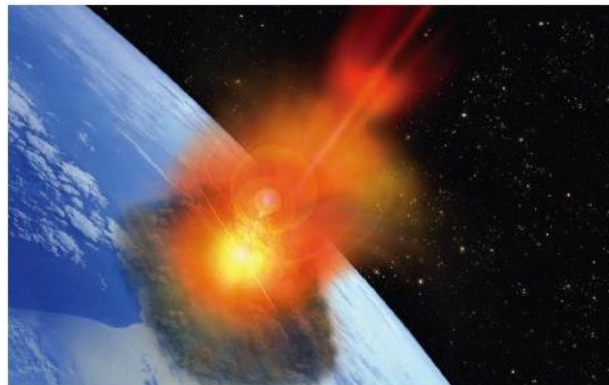
- **Carbon Dioxide-** important greenhouse gas.
  - Without CO<sub>2</sub> to trap infrared radiation from Earth's surface, the average temperature of Earth would be below freezing.



# Factors That Influence Climate: The Movement of Tectonic Plates, and Catastrophic Events

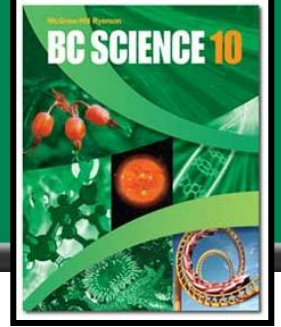


- ◆ Erupting **volcanoes** can release ash and molten rock that absorb radiation.
  - Water vapour and sulfur dioxide (changed into sulfuric acid) can reflect solar radiation back into space.
- ◆ **Meteorites and comets**
  - Large masses strike can produce large quantities of dust, debris and gases that block insolation
  - Possibly responsible for some of Earth's largest extinction events?



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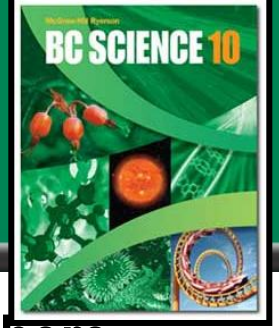
# The Enhanced Greenhouse Effect



- ♦ Human activity add green house gases with high Global Warming Potential (GWP) into atmosphere

**Table 11.1** Greenhouse Gases and Global Warming Potential

Greenhouse Gas	Chemical Formula	Atmospheric Lifetime (years)	Source from Human Activity	Global Warming Potential (GWP)
carbon dioxide	CO <sub>2</sub>	variable	<ul style="list-style-type: none"><li>• combustion of fossil fuels</li><li>• deforestation</li></ul>	1
methane	CH <sub>4</sub>	about 12	<ul style="list-style-type: none"><li>• processing of fossil fuels</li><li>• livestock agriculture</li><li>• waste dumps</li><li>• rice paddies</li></ul>	25
nitrous oxide	N <sub>2</sub> O	114	<ul style="list-style-type: none"><li>• production of chemical fertilizers</li><li>• burning waste</li><li>• industrial processes</li></ul>	298
chlorofluorocarbons (CFCs)	various	45	<ul style="list-style-type: none"><li>• liquid coolants</li><li>• refrigeration</li><li>• air conditioning</li></ul>	4750–5310



- **Ozone is an important UV radiation blocker in the stratosphere.**
  - ♦ **At lower altitudes, however, it is a very powerful greenhouse gas.**
  - ♦ **react with pollution from the burning of fossil fuels, from photocopiers and certain air conditioners.**



- **General circulation models (GCMs) are computer models used to study climate.**

#### Main Fisheries Affected

- changes in the food supply that will affect international trade

#### Water Conflicts

- changes to precipitation patterns, causing the demand for water to surpass the supply

#### Greater Disease Risk

- the occurrence of diseases, such as malaria and other tropical diseases, farther north

#### Sea-Level Rise

- the loss of coastal land due to rising sea levels
- the potential for flood damage to low-lying coastal areas
- the mass movement of people fleeing the worst-affected areas

#### Increased Severity and Frequency of Tropical Storms

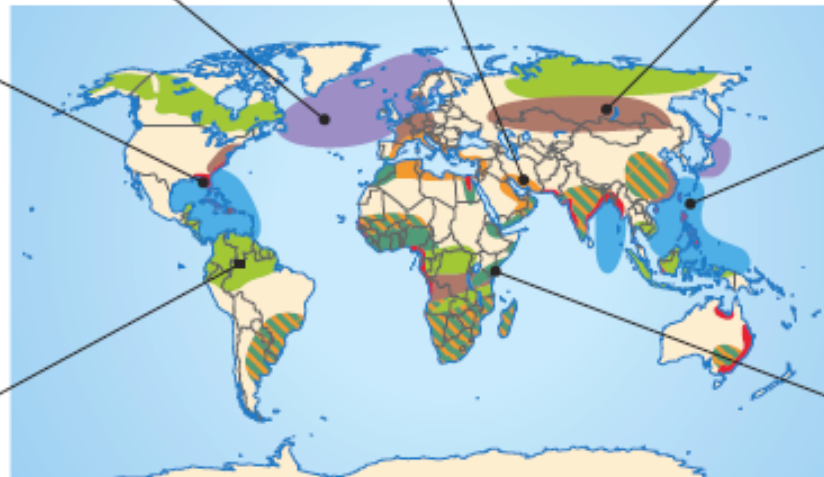
- the mass movement of people fleeing the worst-affected areas

#### Deforestation

- an increase in the risk of forest fires due to a drying climate


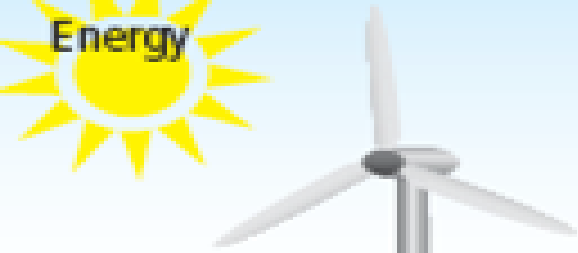
#### Decreasing Crop Yields

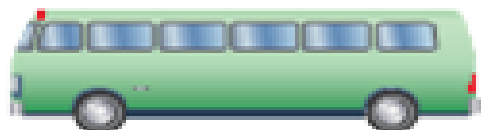

- changes in agriculture and the food supply that will affect international trade



**Figure 11.27** This map shows how climate change could potentially affect all nations of the world.

**Table 11.5 Strategies for Addressing Climate Change**

Sector	Strategy for Reduction of Greenhouse Gas Emission
<p>Industry</p> 	<ul style="list-style-type: none"> <li>• switch to more energy-efficient electric equipment, heat, and power sources</li> <li>• increase the amount of recycling</li> <li>• monitor and control non-CO<sub>2</sub> gas emissions</li> </ul>
<p>Energy</p> 	<ul style="list-style-type: none"> <li>• develop more efficient ways of producing energy</li> <li>• research renewable energy sources (hydro-electric, wind, solar, biofuels, and geothermal power)</li> <li>• store CO<sub>2</sub> underground after it is removed from</li> </ul>

	natural gas
<p>Transportation</p> 	<ul style="list-style-type: none"> <li>• improve fuel efficiency for vehicles</li> <li>• introduce hybrid vehicles, which do not rely on fossil fuels alone</li> <li>• introduce alternate fuels, such as hydrogen or biofuels</li> <li>• shift from road transport to rail</li> <li>• improve and promote the use of public transportation</li> </ul>
<p>Construction</p> 	<ul style="list-style-type: none"> <li>• switch to high-efficiency lighting</li> <li>• use energy-efficient appliances, heating systems, and air conditioning systems</li> <li>• improve insulation of buildings</li> <li>• use solar and geothermal heating and cooling</li> </ul>

## Agriculture



- Improve fertilizer (nitrogen) use
- specify crops used for energy purposes (i.e. corn, soybeans)
- Increased use of soil carbon storage
- Improve management of livestock waste
- Improve techniques for cultivating rice crops
- reclaim and reuse lands damaged by agriculture

## Forestry



- promote world-wide planting of trees and re-forestation
- encourage efficient use of forest products for energy
- encourage better forest-management strategies

## Waste Management



- promote recycling, composting, and minimizing waste
- encourage the burning of waste for energy recovery
- recover methane gas from decomposition in garbage dumps and landfills